D0 ~~Fermilab~~ and the Future of High Energy Physics

Michael Witherell

D0 Meeting

September 2, 1999

The Central Physics Questions, 2000

- New Physics at High Energy
  - Standard Model Higgs
  - Supersymmetry
  - Something else even more surprising

- *CP* Violation, Quark Flavors, Rare Decays
  - *B* Physics
  - *K* Physics
- Neutrino Masses and Mixing
  - Neutrino oscillations

The Present Fermilab Program

The Energy Frontier -- The Tevatron Collider

The luminosity boost from the Main Injector extends the energy range that can be explored.

- EWSB -- Look for a Higgs boson of low mass.
- Supersymmetry -- Look for signs of supersymmetric particles.
- Precise *t*, *W* mass measurements -- Constrain the Higgs mass region further.

The best chance for a discovery in the next 6+ years that would change the direction of particle physics is at the Tevatron.

The Present Fermilab Program

CP Violation and Quark Flavors

- Measure sin 2β precisely enough to show that CKM is predominant source of *CP* violation.
- Measure direct *CP* violation more precisely.
- Measure B_s mixing to determine V_{ts}.
- Look for rare decays of *B*, *K*.

Neutrino Masses and Mixing

- Study source of atmospheric muon-neutrino deficit using a controlled neutrino source.
- Make a definitive check of the LSND anomaly.

Planning the Future

- Our most difficult and important problem is preparing for the long-range future while getting the best physics results possible.
- I have added two new Associate Directors to work on planning the future:
  - I have brought Mike Shaevitz from Columbia to be the Associate Director for Research.
  - Steve Holmes is moving from the Beams Division to be the Associate Director for Accelerators.

  The Deputy Director, Ken Stanfield, will work with Mike, Steve, and me to direct the evolution of the Laboratory.

Planning the Future

- One possible outcome is that we discover new fundamental physics in Run II, such as Supersymmetry.
- As a result, we would
  - have a compelling case to exploit the Tevatron to the fullest,
  - experience a revolution in particle physics greater than that of November, 1974, and
  - be able to see what collider to build next and know that it would do great things.

We refer to this scenario as Plan A.

We are still working on Plan B.

The Immediate Future

The highest priority for the Laboratory is getting D0 and CDF started on Run II physics as soon as possible.

- We need to take the best advantage possible of this extraordinary opportunity.
- The experiments should be well equipped for a long run.

The Tevatron Fixed Target run is in progress and two CP experiments are doing very well.

There is a lot of physics to do with data from the last FT run.

Ongoing Construction Projects

- Run II Upgrades
  - D0
  - CDF
- Neutrino Projects
  - NuMI/MINOS
  - MiniBooNE
- LHC
  - US LHC Accelerator project
  - CMS-US
- Astrophysics
  - Auger Cosmic Ray Experiment
  - Cryogenic Dark Matter Search
  - Sloan Digital Sky Survey

We need to get these projects completed as soon as possible and start doing physics with them.

Funding Outlook

- If FY 00 funding for HEP and Fermilab follows the present guidance (worse of House and Senate bill), the outlook is harsh. This would amount to about a 5% cut in real terms. The House version has us almost keep inflation.
- It would not be surprising if we find ourselves operating on a continuing resolution starting October 1.
- The D0 and CDF upgrade projects will get the remaining project funding.
- Additional manpower is needed to complete assembly stages fast enough.
- We will work with the D0 project management and the collaboration to meet these needs.

Run II Status

- Both D0 and CDF had Lehman reviews in mid-June.
- Findings on the D0 schedule:
  - New schedule shows detector ready for collisions on 7/10/00.
  - The silicon production improvement has not yet been demonstrated (applies to both experiments).
  - The schedule was described as “brittle”; there are parallel critical paths, not just silicon sensor delivery.
  - Lehman committee recommended that D0 reevaluate schedule and provide milestones for tracking progress.
- Findings on the CDF schedule:
  - New schedule shows detector ready for collisions on 9/29/00.
  - CDF has proposed rolling in partial detector for engineering run.
  - Lehman committee recommended that CDF provide milestones for tracking progress over the remaining steps.

Run II Schedule

- We are taking a close look at the schedule of the collider and of the experiments:
  - We are continuously obtaining a better picture of the schedule for silicon sensor deliveries.
  - We are looking at other detector systems near the critical path.
  - We are working to understand the accelerator schedule.
- We are getting presentations on the detailed schedule:
  - Beams Division August 1.
  - D0 September 14.
  - CDF Septermber 21.
- During October we will develop and publish the schedule effective from then until the start of Run II.
- Our goal is to develop a schedule that we can keep.

Finishing the D0 Upgrade

- We are in the last lap of a long race.
- We will work hard to get D0 running as soon as possible.
- The D0 collaboration needs to do everything it can to complete the upgrade, install the detector, and start doing physics on the new schedule.

Collider Upgrades Beyond the Baseline

Two upgrades for each collider detector were given stage 1 approval, and have been working on getting the funding commitments needed for stage 2 approval.

For D0:

- The Silicon Track Trigger appears to be ready for stage 2 approval at the next PAC meeting.
- Efforts to obtain full funding for the Forward Proton Detector are continuing.

The Long Run II

- The Physics case for extending Run II with improved luminosity is clear. Every factor of 3 in integrated luminosity significantly increases the probability of a major discovery.
- The primary goal for the next six years is to deliver as much useful integrated luminosity to D0 & CDF as possible.
  - We want to minimize the length of shutdowns.
  - Major rebuilds of the detectors are not foreseen, although replacement of the inner silicon with rad-hard technology will be needed. We plan to time the shutdown for this with a major shutdown to upgrade the collider complex.
  - We will use 2006 as the LHC year, but our planning needs to allow for possible slips in that date.

The Long Run II

- The entire period of Tevatron collider running from now until the LHC is running will be considered Run II.
  - We will not have a 3-year shutdown of the collider program, as we did between Runs I and II.
- The Beams Division will develop a detailed plan of how to upgrade the luminosity within the constraint of 1 shutdown of no more than 9 months.
- The expectations for integrated luminosity might be
  - 2 fb^{-1} by 2002,
  - ~15 fb^{-1} by 2006,
  - more if start of LHC physics is somewhat later.

Scientific Priorities

The following is a summary of the PAC statement on Scientific Priorities:

- **During the next six years, the highest priority of the Laboratory will be the successful operation of the Run II collider program.**
- The second important goal of the Laboratory during this period is the definitive observation of neutrino oscillations in a neutrino experiment.
- and...

Summary

- The Laboratory has first to get Run II up and running well. We then need to get the experiments as much integrated luminosity as possible.
- We have to meet our commitments to get the neutrino projects built as quickly as possible.
- We will continute to be very active in LHC, both accelerator and physics.
- We need to start doing more accelerator R&D on the colliders of the future.
- We have two attractive opportunities for new programs: BTeV and 120 GeV FT. We will decide how to proceed with these in FY 2001 based on the reviews of the proposal and our best estimate of funding prospects.